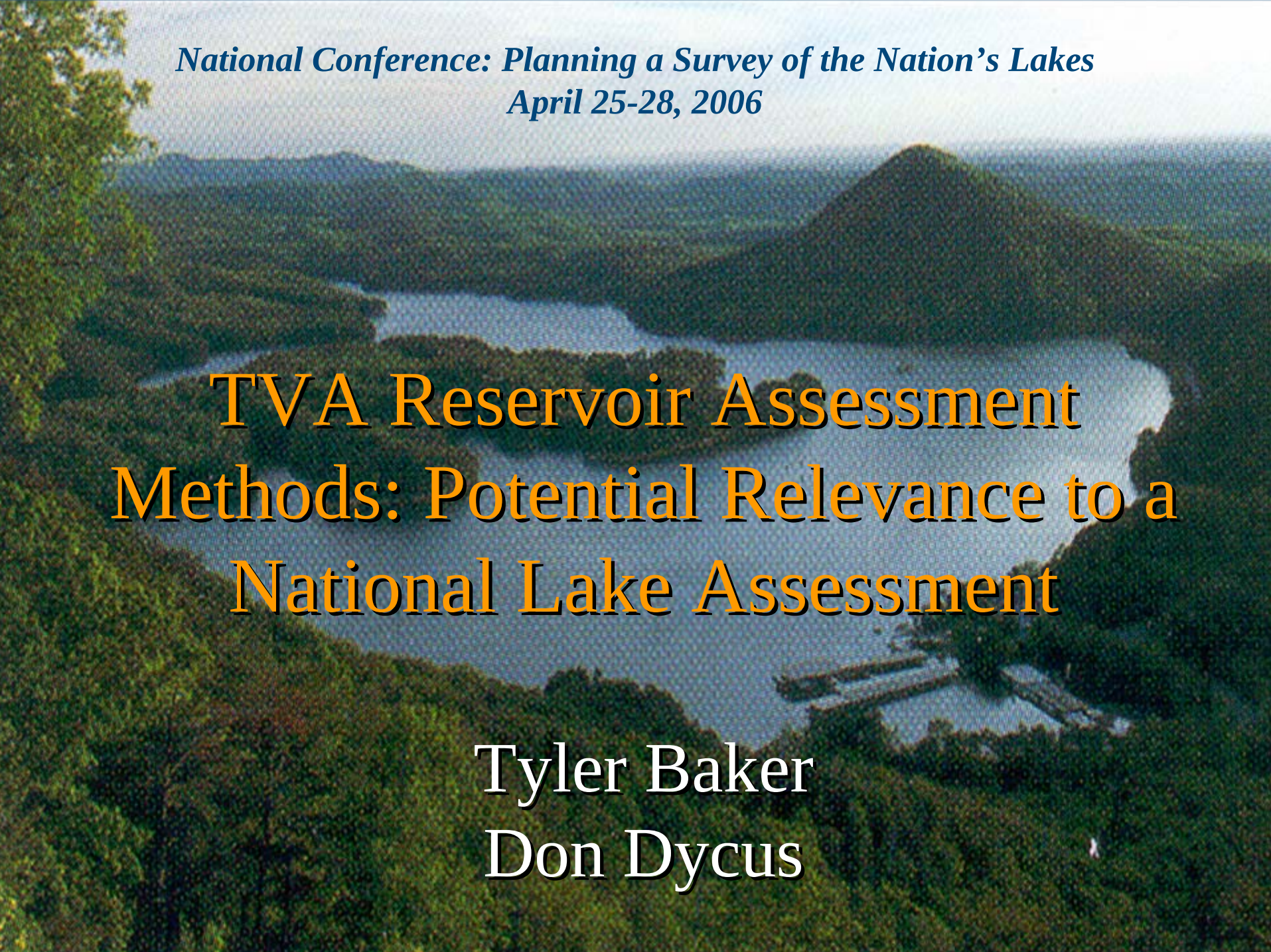


National Conference: Planning a Survey of the Nation's Lakes
April 25-28, 2006

TVA Reservoir Assessment Methods: Potential Relevance to a National Lake Assessment

Tyler Baker
Don Dycus

Why Is TVA Involved in Water Quality Monitoring?

- TVA's focus for its monitoring program is aimed at:
  - Stewardship responsibilities
  - Operating the reservoir system
  - Responding to stakeholders

- TVA has no regulatory authority related to water quality monitoring.

- TVA monitoring is not aimed at use attainment *per se*.

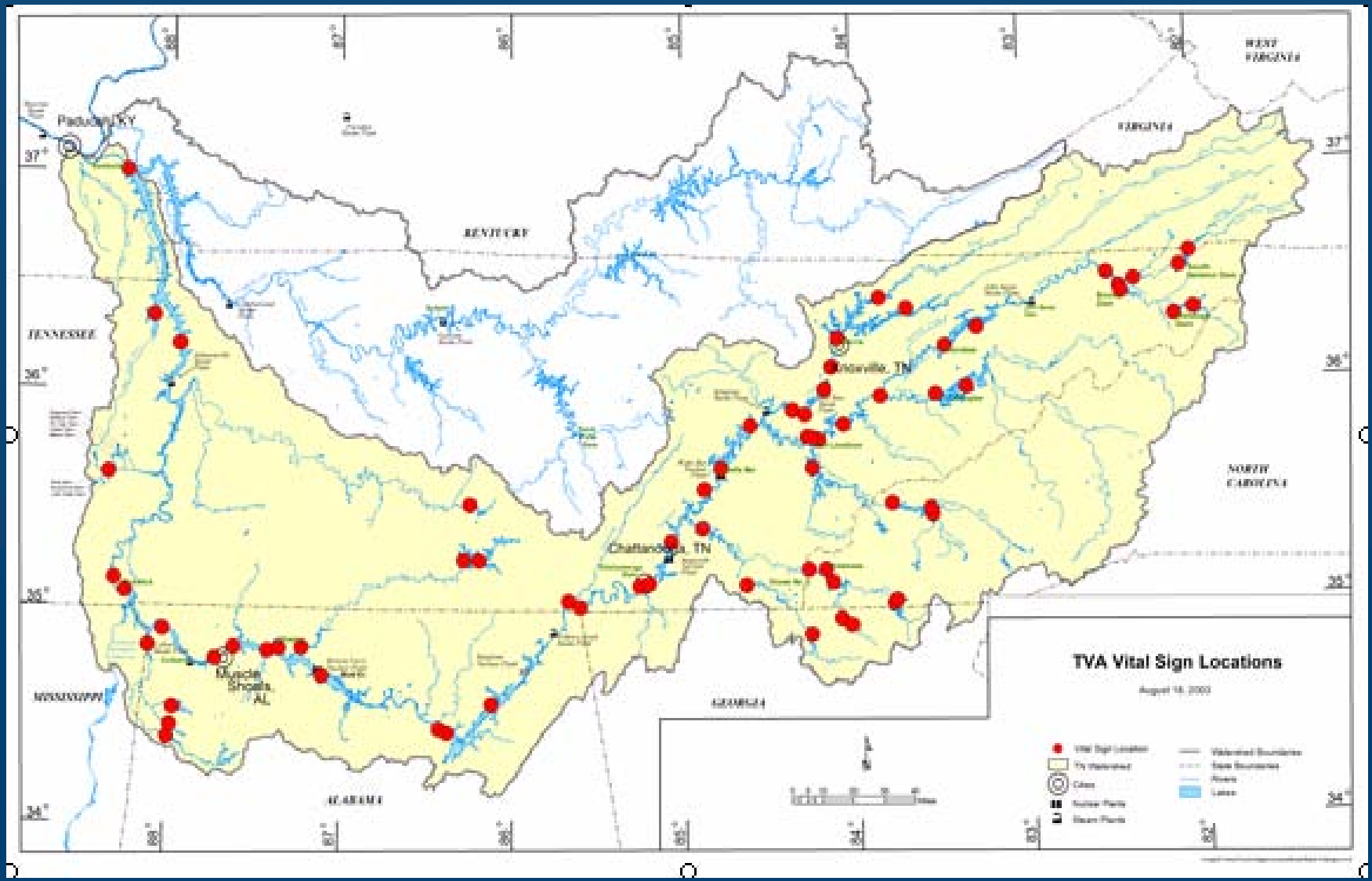
Reservoir Vital Signs Monitoring

TVA began a program to systematically monitor the ecological condition of its reservoirs in 1990, termed Vital Signs Monitoring. Prior reservoir studies had been confined to reservoir specific assessments to meet specific needs as they arose.

Scope:

- Systematic monitoring program started in 1990 with 12 reservoirs
- Now includes 69 sites on 31 reservoirs
- Rotating system where each reservoir is sampled every other year (after initial five year period).

Reservoir Ecological Health Sampling Locations



Characteristics and Properties of Reservoirs

"Because reservoirs are entirely artificial environments, 'natural reference condition' has no meaning. Reservoirs, created by the damming of a stream, have characteristics of both rivers and lakes."

EPA, "Lake and Reservoir Bioassessment and Biocriteria Technical Guidance Document," 1998.

http://www.epa.gov/owow/monitoring/tech/lakes.html

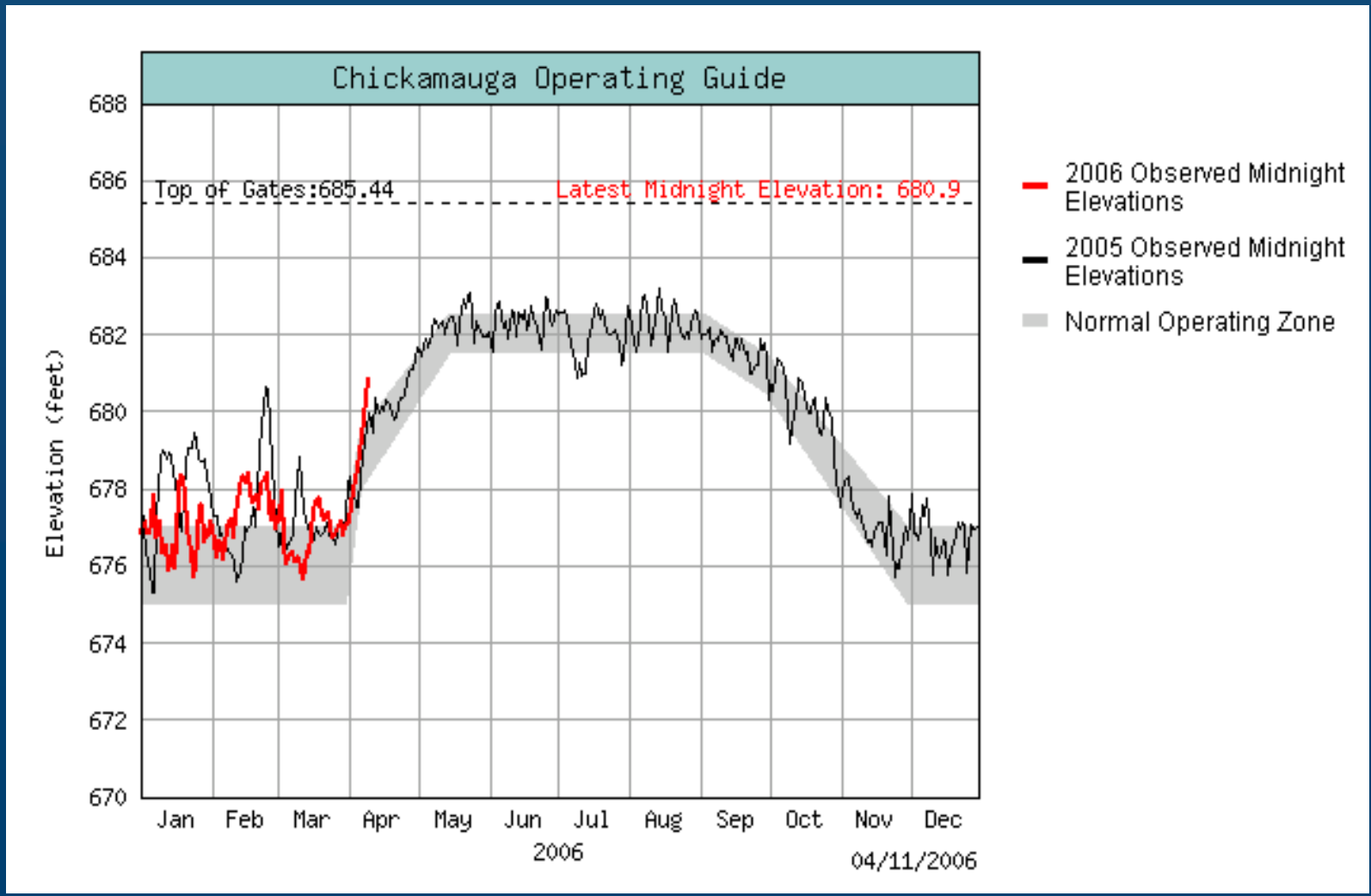
Characteristics and Properties of Reservoirs

Management

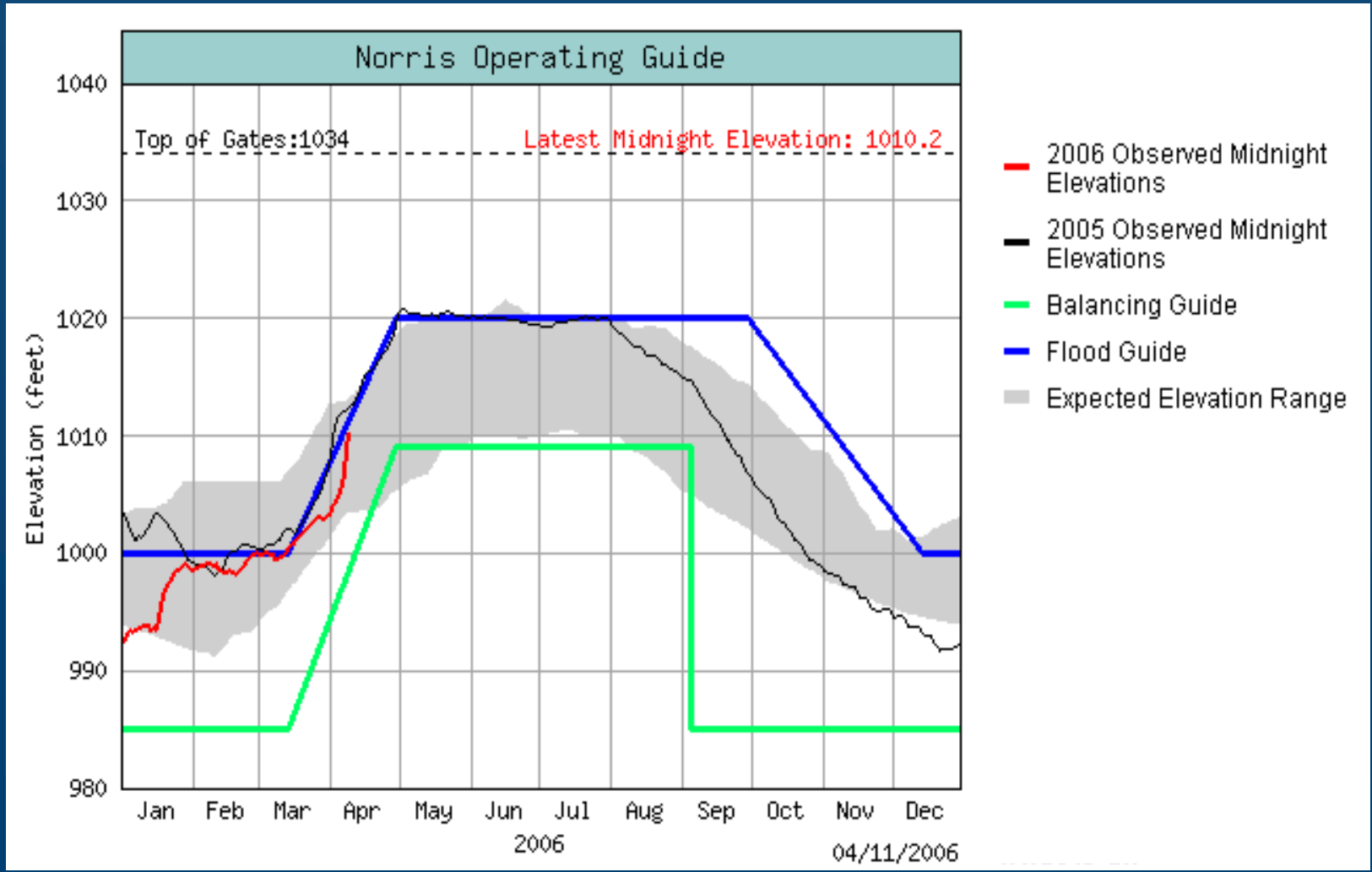
- Reservoir were built and are managed for specific purposes: hydro-power, irrigation, flood control, navigation, fisheries, water supply, recreation, and multiple uses.

- Operational strategies regulate the storage and flow of water in response to rainfall and runoff and thereby greatly influence characteristics and resultant water quality.
  - Water level fluctuations (large, irregular)
  - Releases/Flushing rates (highly irregular with water use; both hourly and seasonal fluctuations)

Mainstem Tennessee River Reservoir Operating Guide



Tributary Reservoir Operating Guide



Characteristics and Properties of Reservoirs

- Distribution – Reservoirs are more numerous in the southern U.S in non-glaciated regions
- Drainage Basin – Reservoirs are often created by damming high order streams. Therefore, reservoirs tend to be more elongate than natural lakes and the watersheds are typically much larger and contribute greater nutrient and sediment loads.
- Longitudinal gradient – A reservoir typically has characteristics of both lakes and rivers, with river-like characteristics in the upper reaches and more lake-like near the dam.
- Withdrawal depths (surface layers or hypolimnion)
  - Hypolimnetic release – The release of water from the lower water column increases heat gain, expedites mixing in the fall (fall turnover), and discharges materials accumulated in bottom waters.

Characteristics and Properties of Reservoirs

- Benthic Fauna – Low diversity; primarily tolerant organisms remain; Reservoirs tend to have minimal and irregular littoral zone

- Fish – Adaptive river community; fish that remain are those that are able to adapt to reservoir environment. Reservoir fish communities are often intensively managed to maximize recreational angling.

Reservoir Retention Time

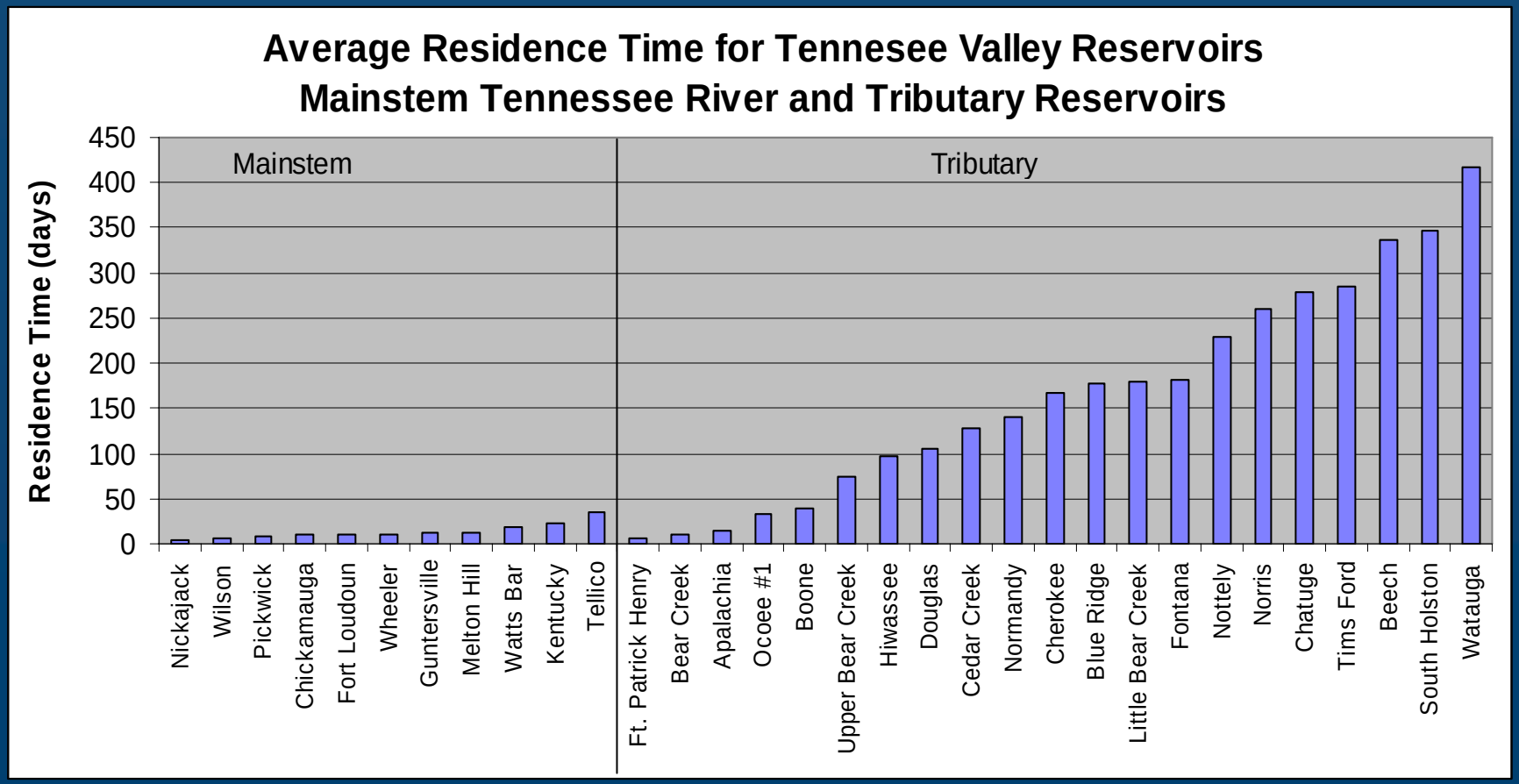
- Influences thermal stratification, which affects dissolved oxygen, especially at lower depths
  - Mainstem reservoirs typically have short retention times and are well mixed or stratification is more transient.
  - Tributary reservoirs often have long retention times and stratification and oxygen depletion are expected

- Influences nutrient dispersion and algal productivity – (Luxuriant algal growth exists unless limited by some factor (e.g., nutrients, light, and/or retention time.)
  - For mainstem run-of-river reservoirs retention time is most often the limiting factor
  - For tributary reservoirs nutrient availability is usually limiting factor

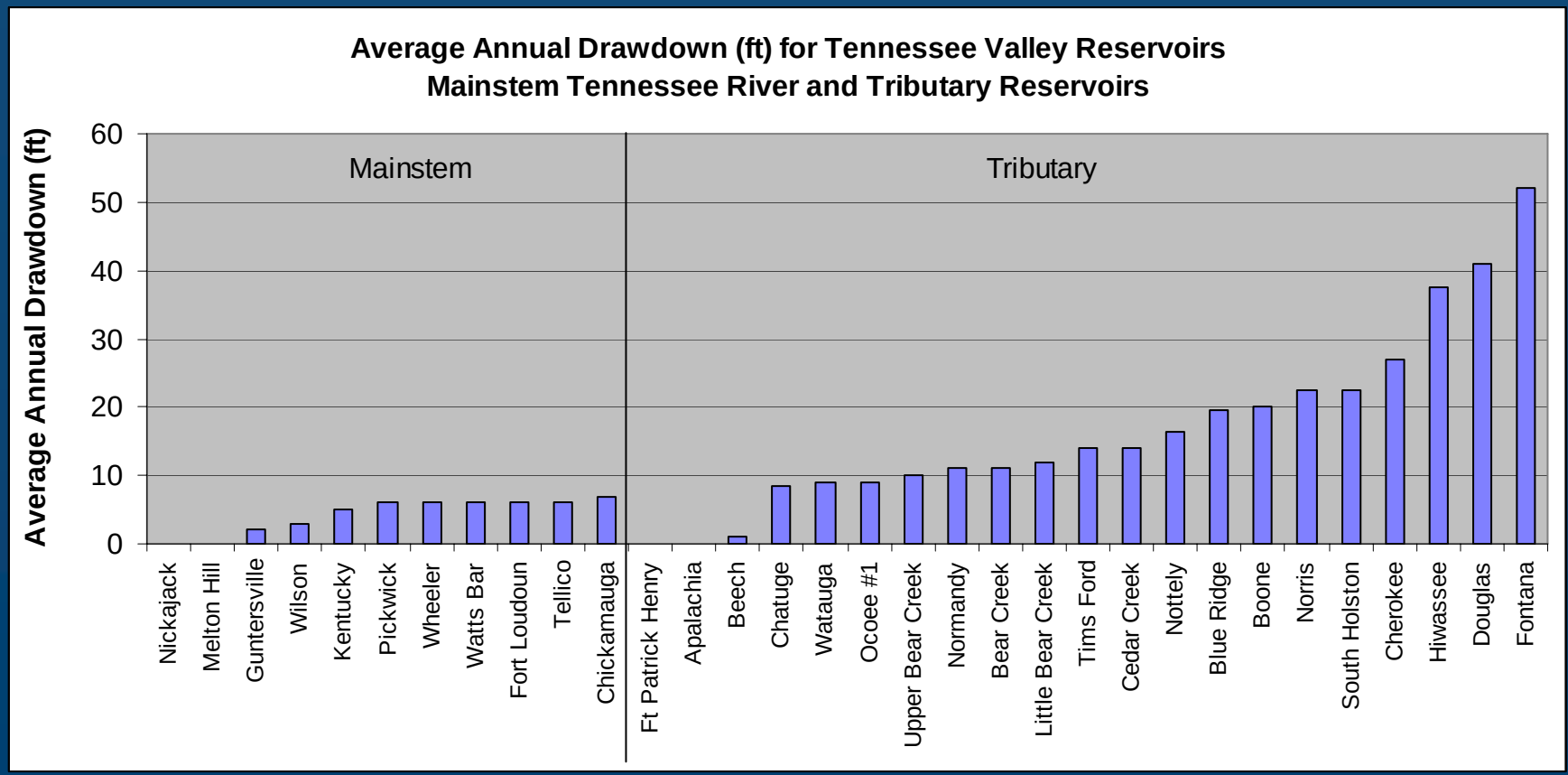
Differences Among Reservoirs Create Need for Classification

(Important Considerations: size, gradient/depth, ecoregion, reservoir management objective, etc.)

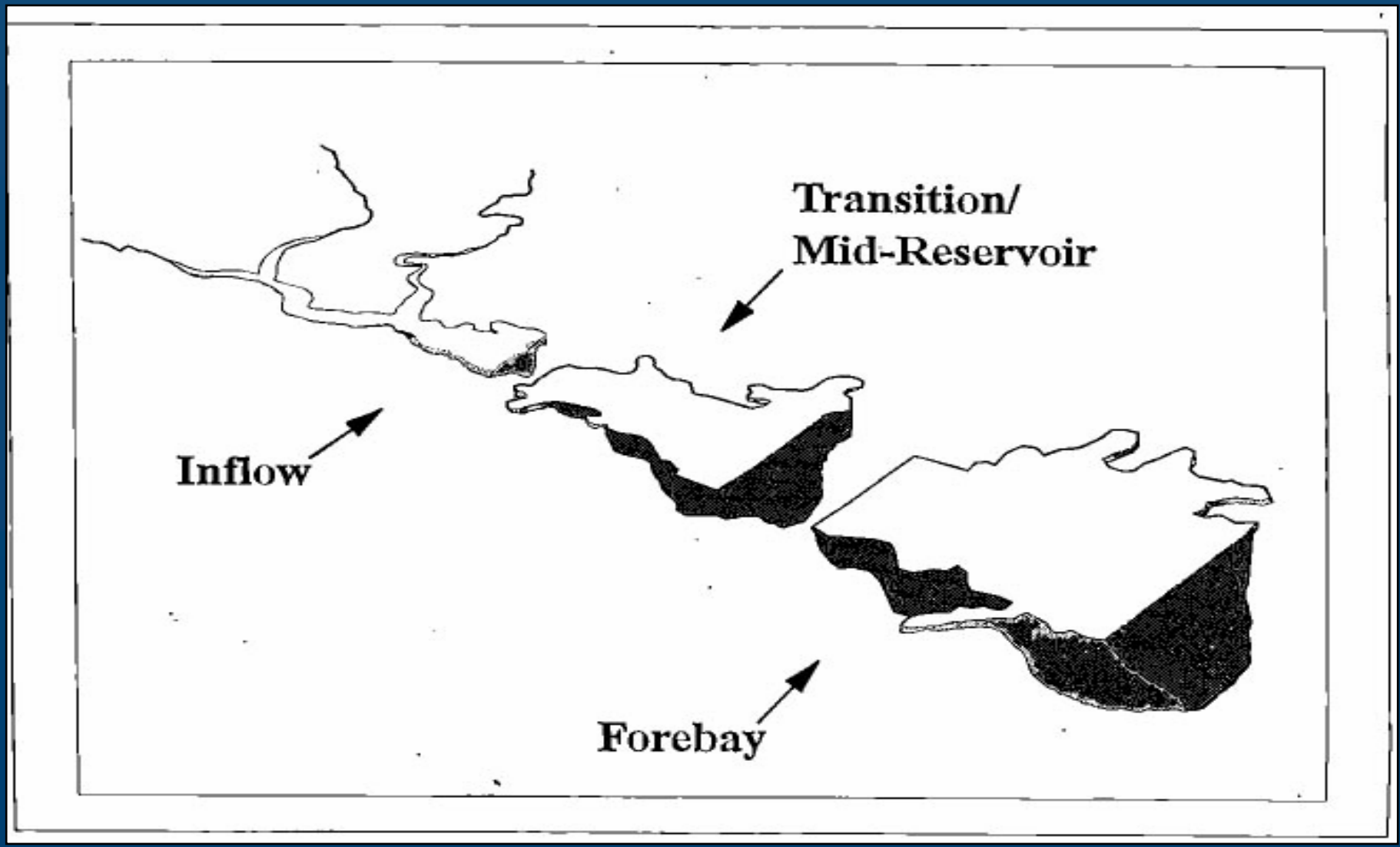
Differences Among Tennessee Valley Reservoirs



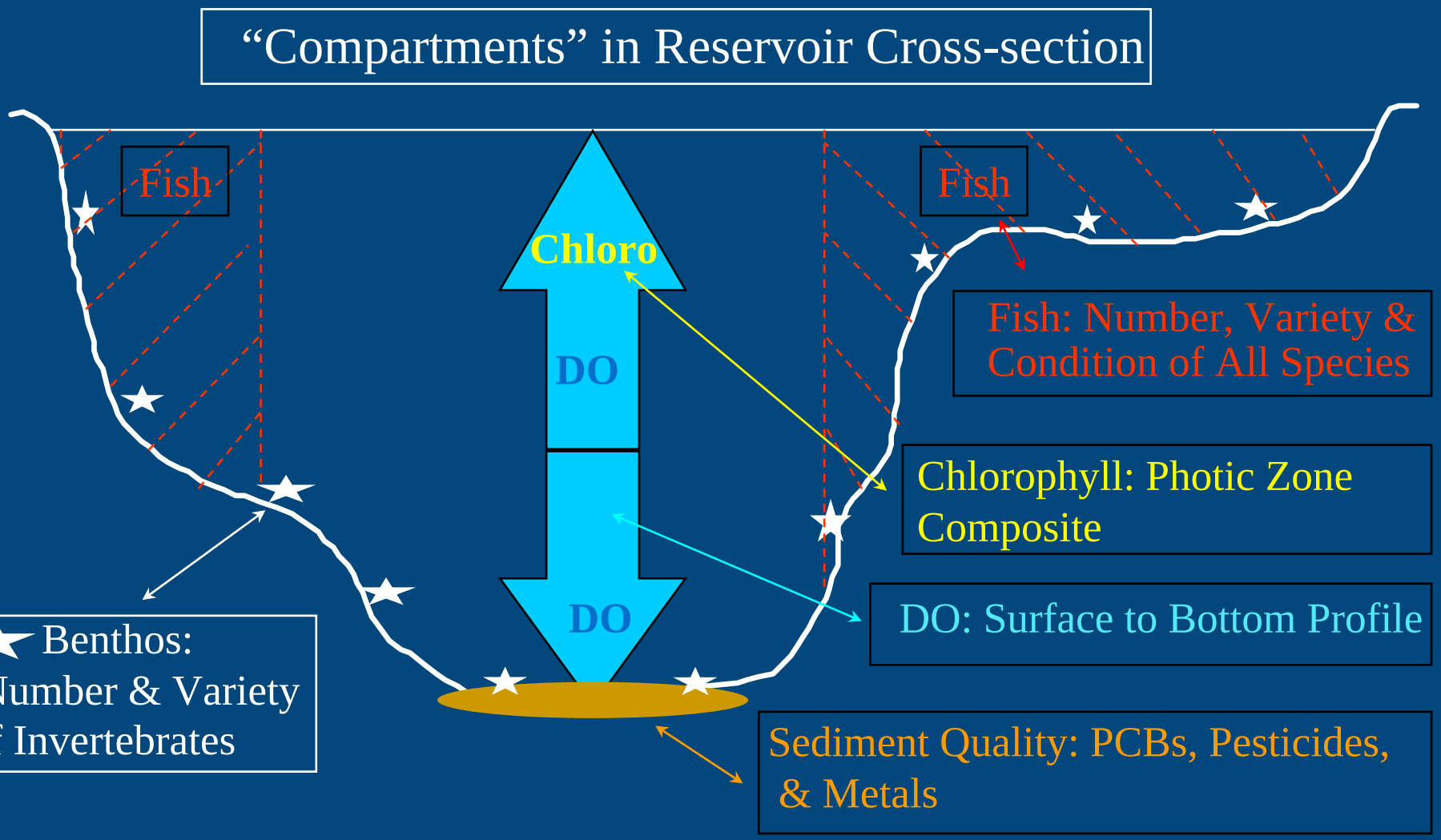
Differences Among Tennessee Valley Reservoirs



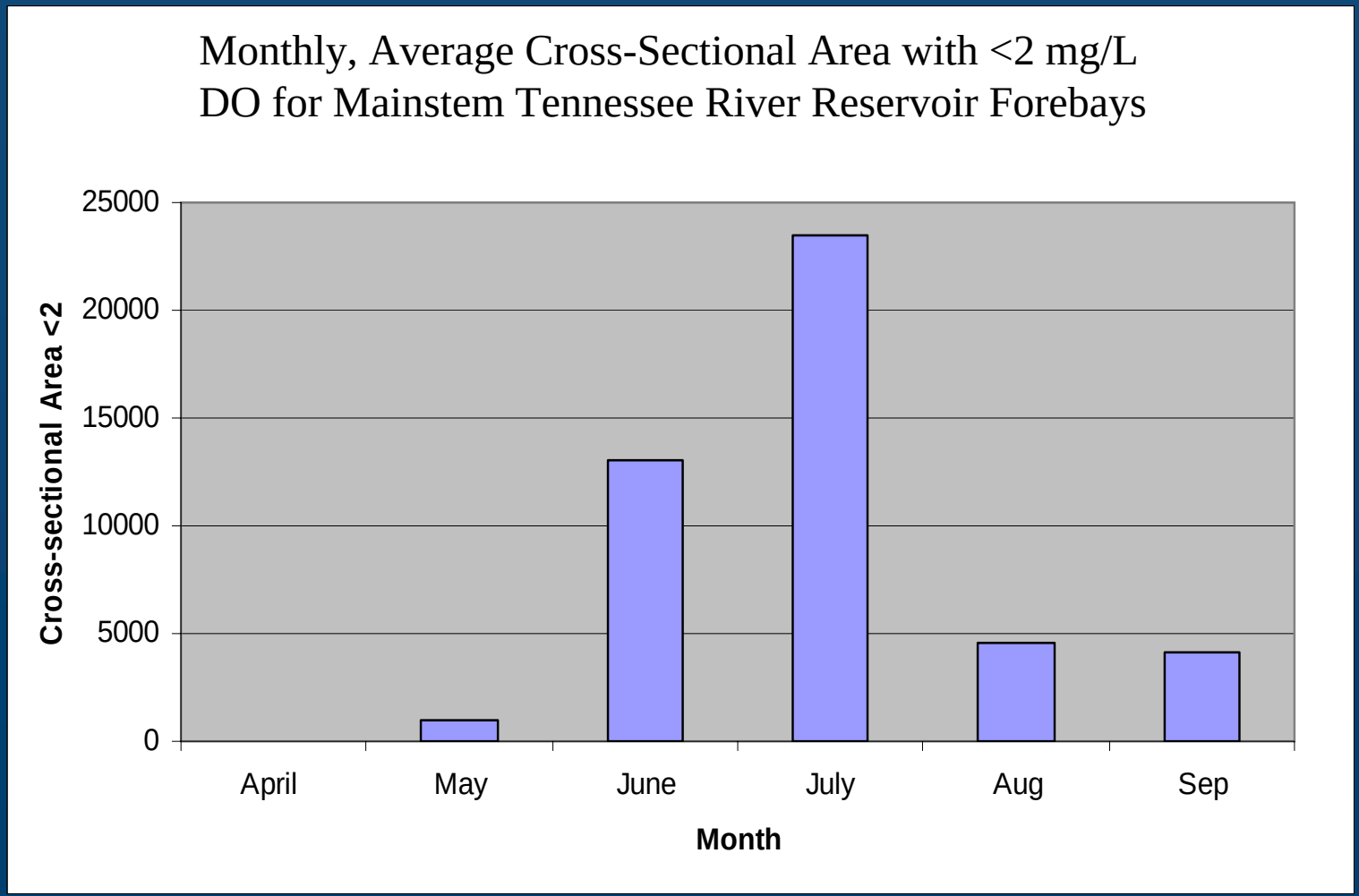
Differences Among Reservoir Zones – Considerations for Sample Locations



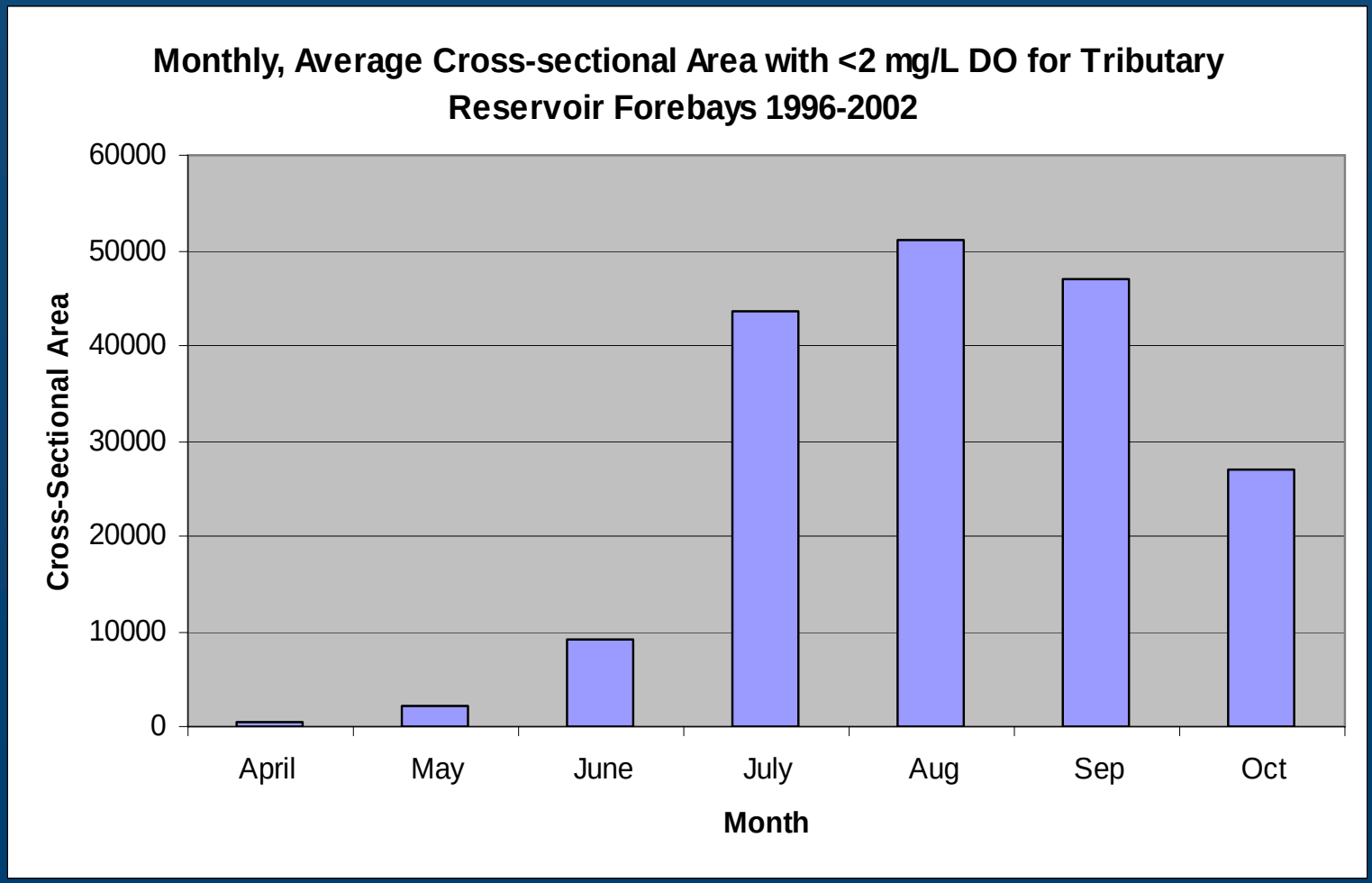
Differences in Reservoir Cross-sectional Compartments and Need for Multiple Indicators (Weight of Evidence)



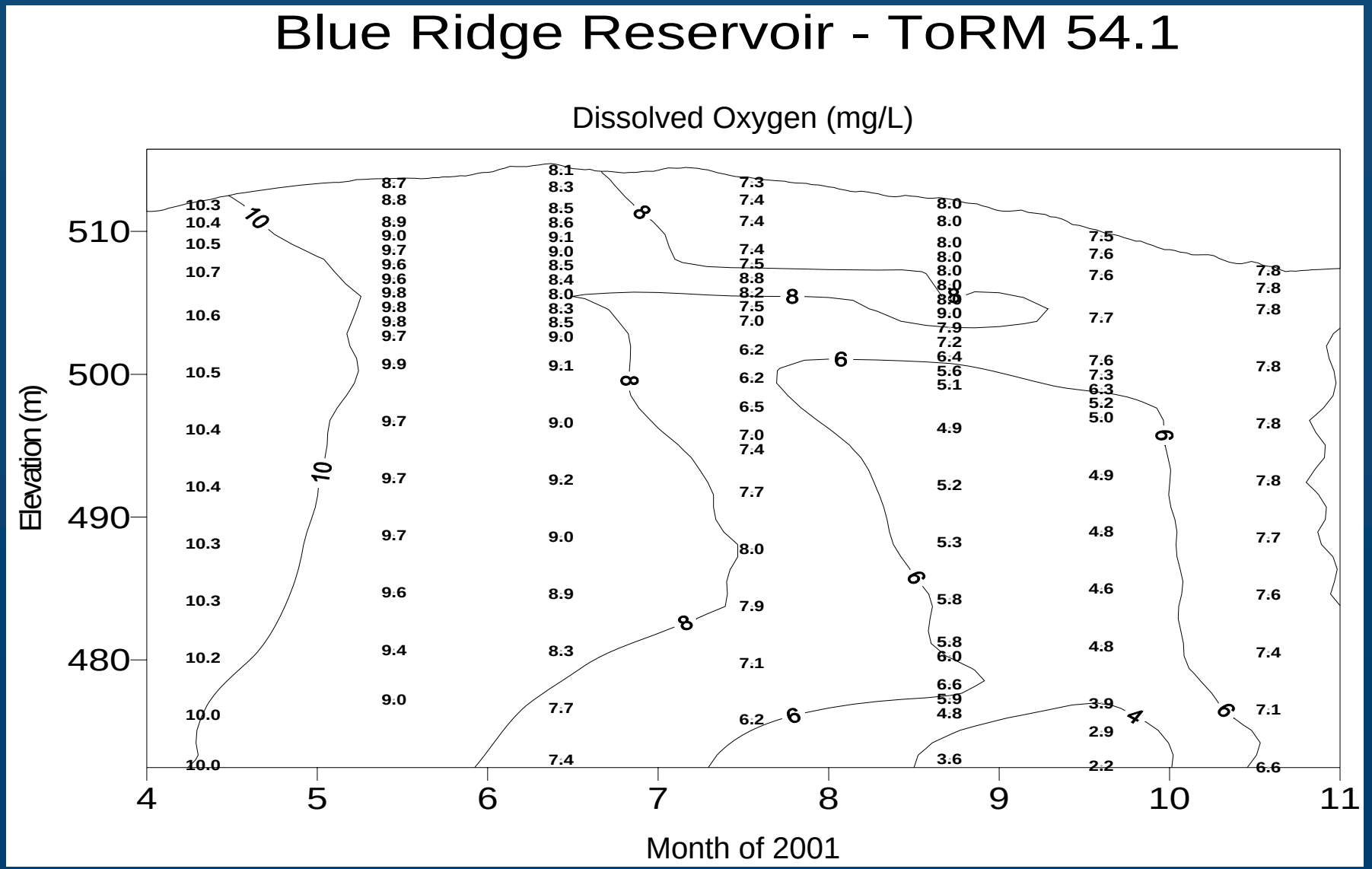
Hypoxia (DO <2 ppm) in Mainstem Reservoirs



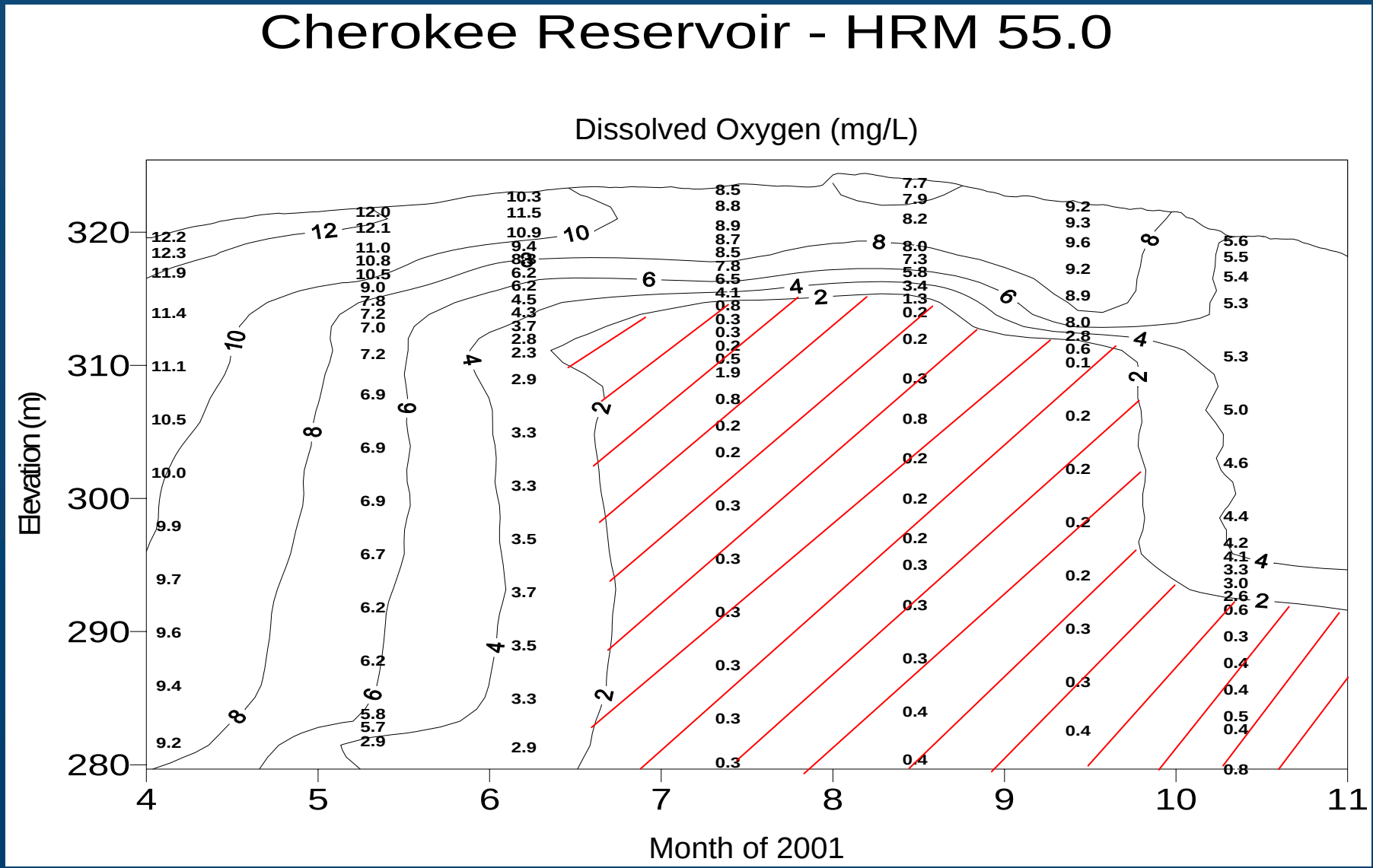
Hypoxia (DO <2 ppm) in Tributary Reservoirs



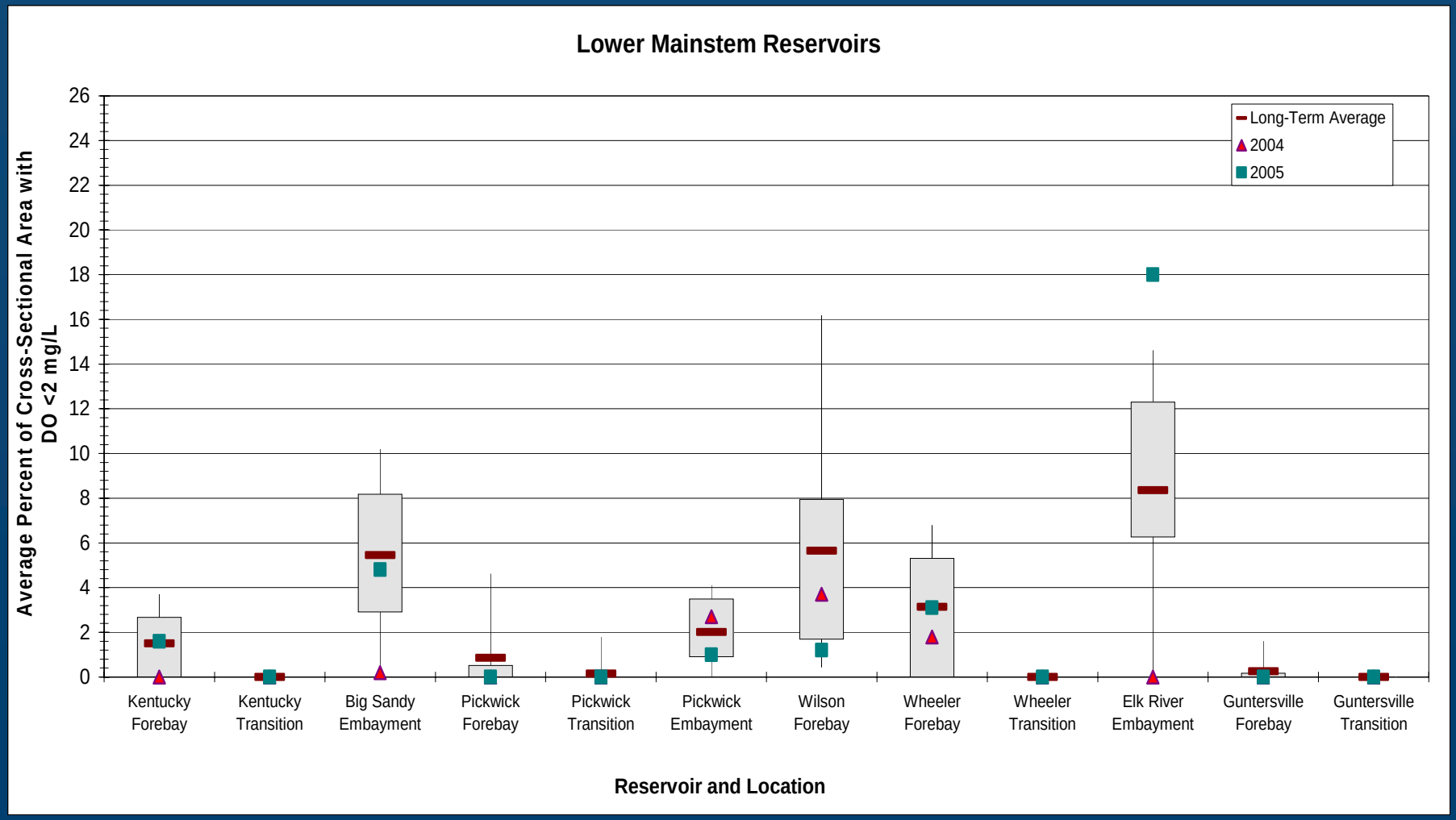
Example of a Reservoir with a Good DO Rating



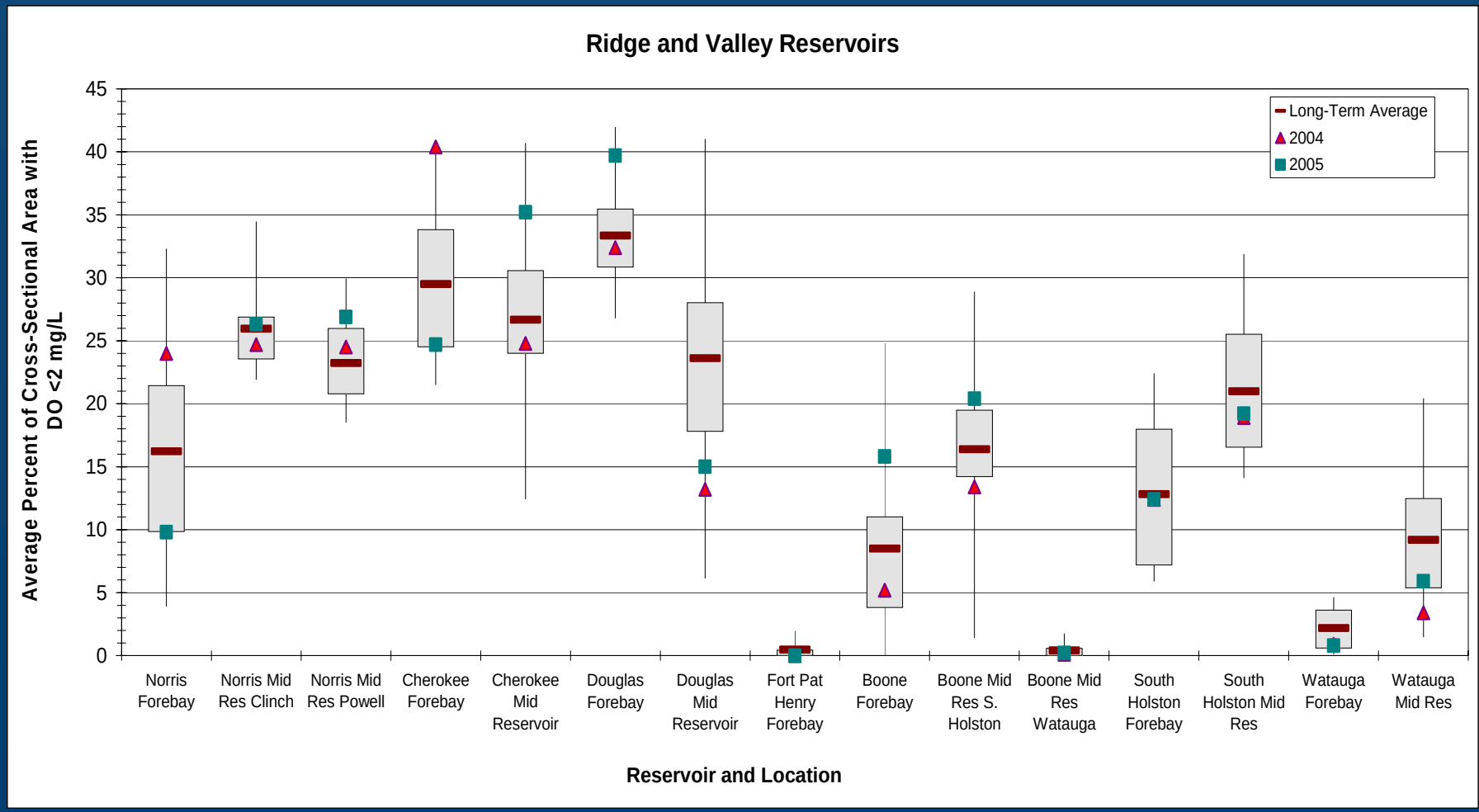
Example of a Reservoir With a Poor DO Rating



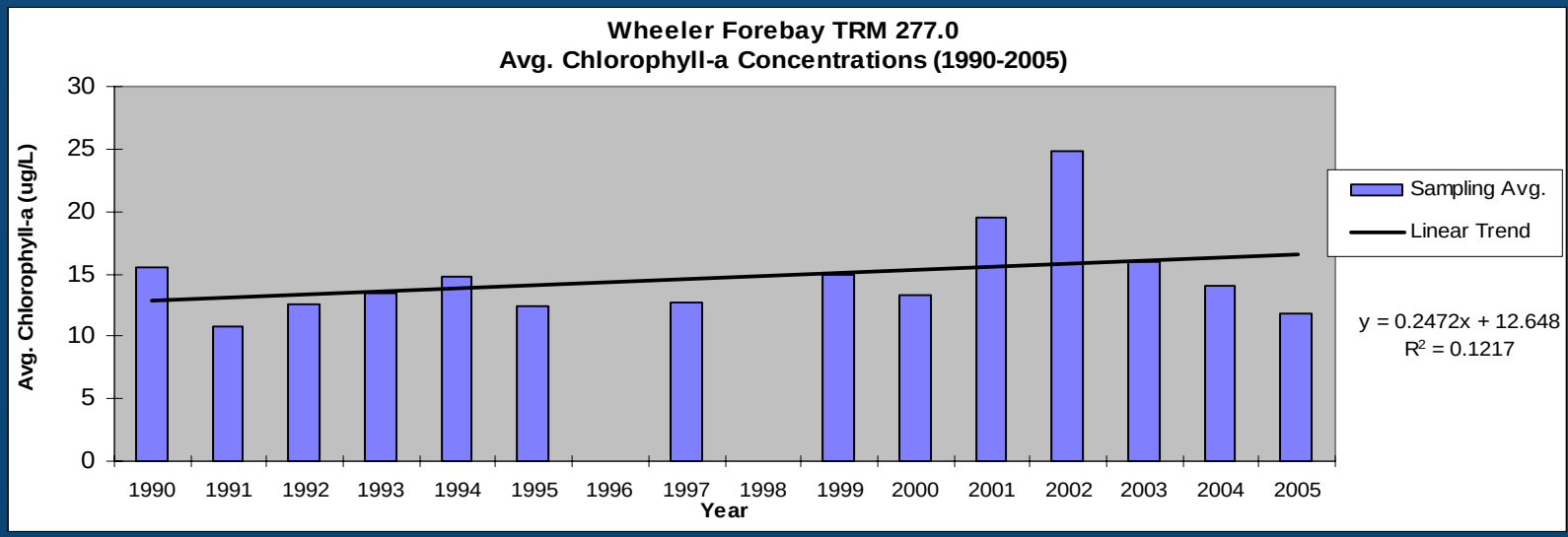
Average Percent of Cross-Sectional Area with DO <2 mg/L

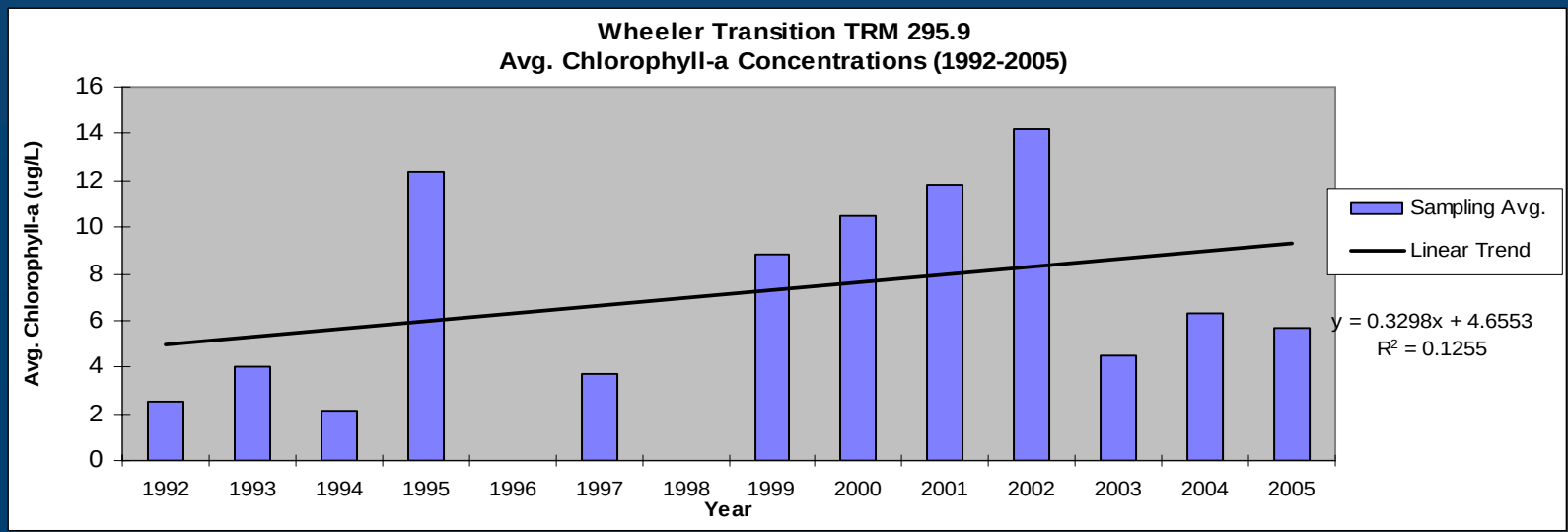


Average Percent of Cross-Sectional Area with DO <2 mg/L

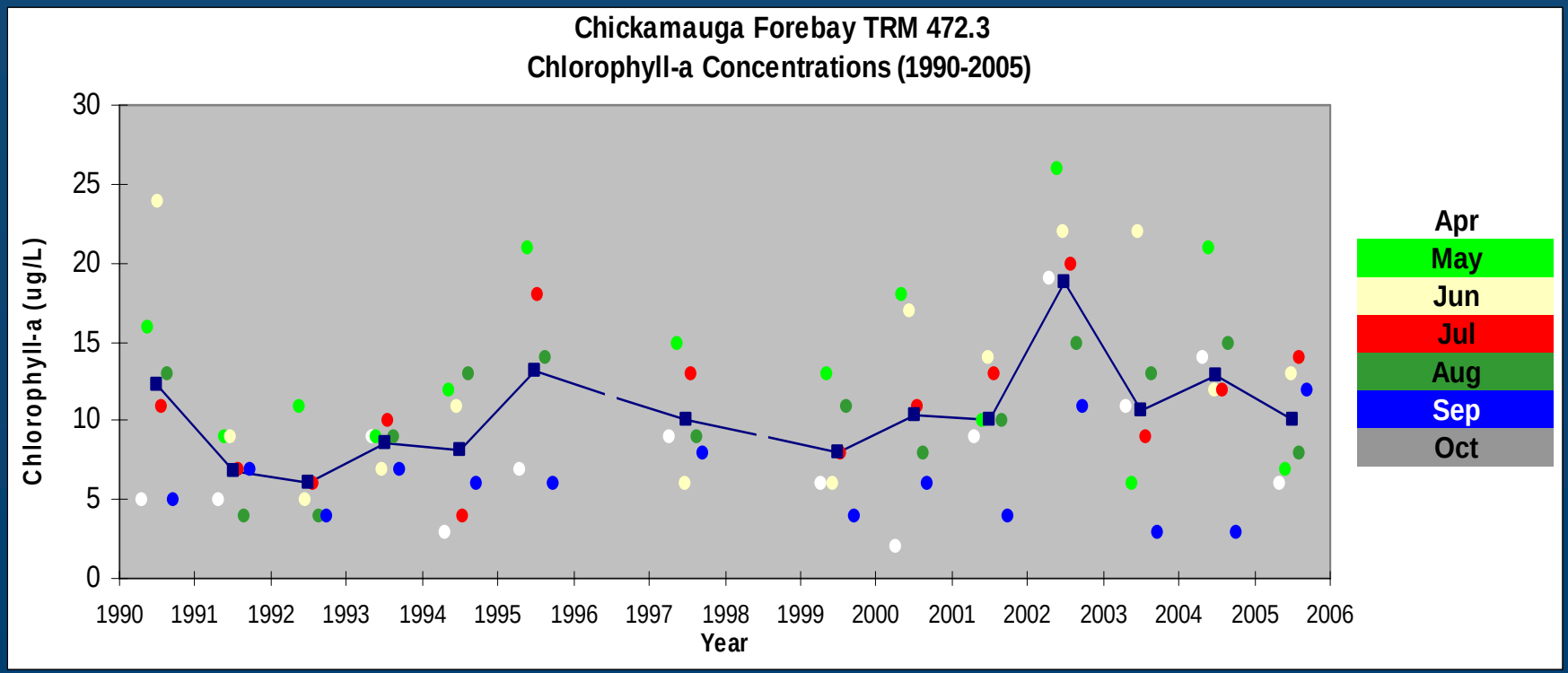


Chlorophyll_a Trend at Wheeler Reservoir Forebay and Transition Monitoring Sites

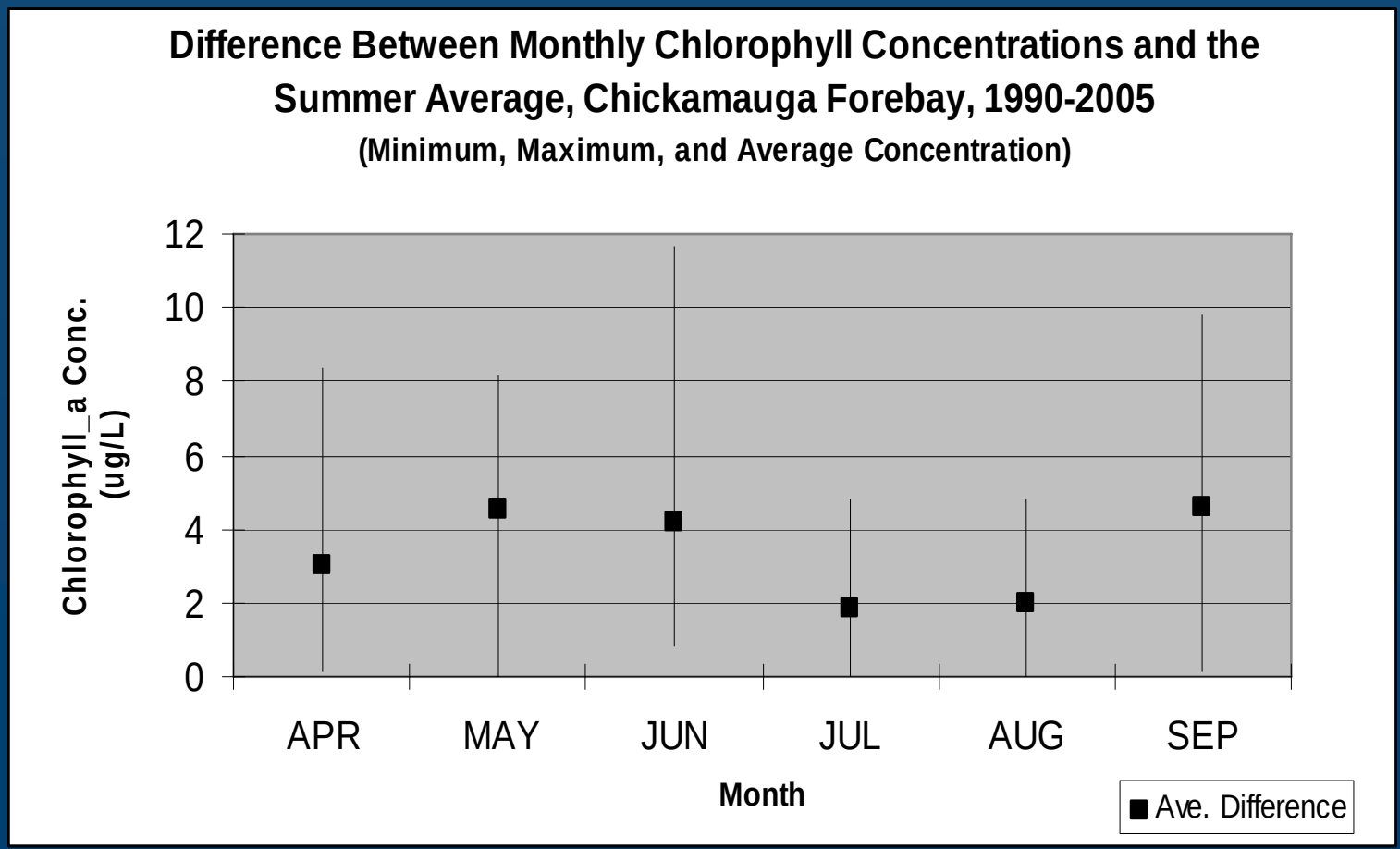




Monthly Chlorophyll_a Concentrations in the Forebay of Chickamauga Reservoir, 1990-2005



Monthly Chlorophyll_a vs. Summer Average Concentration, Chickamauga Reservoir Forebay, 1990-2005



Summary

- Reservoirs are artificial systems and, therefore lack natural reference sites for determining characteristics that would be expected in waters unaffected by human impacts.
- Reservoirs are very dynamic systems, possessing characteristics of both rivers and lakes in the same waterbody.
- Reservoir water elevations and flows often are highly regulated to meet intended use(s).

Summary

- Study design and data interpretation must be based on an understanding of the complex interactions between response indicators and controlling variables such as nutrient dynamics, dam operations (including short- and long-term hydraulic retention time, depth of withdrawal, etc.), and weather conditions.

Reservoir Limnology. by Thornton, Kimmel, and Payne. 1990.

Chapter 9: “Reservoir Ecosystem: Conclusions and Speculations” by Robert G. Wetzel

“In order to effectively manage and utilize reservoirs, however, it is important to understand the structural differences between these man-made ecosystems and natural lakes while simultaneously appreciating their functional similarities.”